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Effect of Ground Nut Cake Supplement on Milk Production Performances and Economic Return of Dairy Cows

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Abstract: A study was conducted to evaluate the feeding value of ground nut cake (GNC) with concentrate feeds on milk yield and its economic feasibility. Changeover design was used in three periods each comprising 25 days plus the first seven days for adaptation and ten days for wash out of residual effect between consecutive periods. Treatment diet was ground nut cake (GNC) while soya bean meal (SBM) was used as control levelled at a ratio of 0 GNC: 100 SBM (T1), 50 GNC: 50 SBM (T2) and 100 GNC: 0 SBM (T3). The concentrate diets were maize, wheat bran, minerals and vitamin premix while basal diets grass hay and corn silage were fed ad libitum. Data were analysed using the General Linear Models procedure of SAS. Daily milk yield was higher (P<0.05) for T3 (18.71 l/d) and T2 (18.17 l/d) as compared to T1 (17.96 l/d). Milk yield differed (P<0.05) between treatments with stages of lactation. Economic analysis showed the highest net return for T3 and the lowest from T2. In general, Replacement of ground nut cake for soybean meal improved milk yield and economic return.

Keywords: Cake, Effect, Milk, Ground Nut Cake, Performance, Soybean

1. Introduction

Agriculture is the main economic activity in Ethiopia, with more than 80% of the population relying on agricultural activities, with livestock playing a very important role. Agriculture contributes 50% of GDP, 85% of employment (Ethiopia's rural population), 90% of export earnings and 70% of countries' raw material needs. [1] It is said that agriculture contributes 47.3% to GDP. Livestock is an important part of agriculture and the contribution of livestock and its products to the agricultural economy accounts for 47% [2]. Livestock contributes in one way or another to the livelihood of 60-70% of the Ethiopian population. The dairy industry contributes significantly to gross domestic product (GDP). Milk production plays an important role in the livelihoods of Ethiopians. Ethiopia is estimated to have the largest livestock population in Africa, with approximately 59. 5 million cattle, 30. 7 million sheep, 30. 2 million goats 2.1 million, horses 8. 44 million, donkeys 0. 41 million, mules 1.21 million, camels 56.53 million, poultry and 5.92 million animals. Honeycombs are found in water [3]. Among these dairy cows, there are an estimated 7. 16 million dairy cows and about 11. 83 million dairy cows, of which 98. 2% of the total dairy herd in the country are local breeds. The rate of hybrid and foreign breeds is low, only 0.18%. According to [4], the number of dairy cows nationwide varied greatly over the 15-year period from 1996 to 2010. The number of cows tended to increase from about 8.8 million in 1996 to 11 million in 2001 and decreased. Strong down to about 7.9 million animals in 2001. In 2003, this number then increased to 9.6 million in 2010. Although Ethiopia has the largest dairy herd, milk production is very low. The country's per capita milk consumption is estimated at 19 kg/year, much lower than Africa's per capita consumption of 37.2 kg/year [5]. The report of food and agricultural organization shows that the per capita milk consumption in Ethiopia is about 17 kg much lower than the 200 kg recommended by the World Health Organization and 62.5 kg is the minimum for a country balancing diet [6, 7]. This latter figure is still much lower than the global average of 100 kg per capita per year.

Milk production has increased steadily from about 927 million liters in 1996 to 2.9 billion liters in 2010. The total volume of milk produced in Ethiopia has increased gradually over the past 15 years, from less than 1 billion liters to 3.0 billion liters in 2014/15. Although the dairy herd is large, milk production per cow per day in Ethiopia is very low.

Many researchers explain that low productivity is mainly due to ineffective management and nutrition practices, low genetic potential of indigenous cattle, high disease and parasite incidence, poor access to Poor credit and extension services as well as lack of information to improve livestock performance [8]. Among these limitations, lack of quantity and quality of food ingredients is the main factor limiting the development of milk production in urban and peri-urban dairy systems [9]. In Ethiopia, natural and improved pastures (in small quantities), crop residues, fodder crops, agro-industrial by-products and unconventional feeds constitute the main feed source for livestock [10]. The contribution of these food sources depends on the agro ecosystem, crop type, accessibility and production system, with natural grasslands being the main source [11]. Livestock continue to make an important contribution to the food supply and, as a result, animal feed is becoming an increasingly important part of the integrated food chain. Meeting consumer demand for meat, milk, eggs and other animal products depends greatly on a regular supply of suitable, cost-effective and safe animal feed. Several issues have caused much public concern recently, however, the amount of protein in animal feed is very important [12]. According to [13], energy and protein are the most important factors affecting milk performance. Adequate nutrition and balanced rations remain the foundation of a successful dairy farm. [14], based on milk yield responses and the level of milk production achieved by cows, concluded that 17% dietary protein is sufficient for maximum milk production during the first seven weeks of lactation.

A higher protein concentration (19%) is required from seven to sixteen weeks of lactation, but after that, 17% protein is sufficient until thirty weeks and 16% CP is sufficient after thirty weeks of lactation. [15] Concluded that even in late lactation, when milk yield is reasonably low, milk yield often increases when supplemented with CP. However, when crude protein concentration in the diet falls below 16% dry matter, NDF digestibility decreases, which can lead to reduced energy intake, which in turn reduces the animal's milk production performance are breastfeeding.

1.1. Statement of the Problem

In the current scenario, milk yield per cow and feed cost for milk production have the greatest influence on dairy farm profitability [16]. The main constraints to increasing milk production in all dairy production systems are insufficient feed resources, poor pasture development and increasing feed prices. Feed usually accounts for about 70% of the total cost of milk production [17]. It is therefore important in ruminant nutrition to minimize the cost of diets by including well-formulated and relatively inexpensive but often fibrous ingredients, while ensuring adequate supply. Provide adequate digestive nutrients [18]. To overcome the problem of animal feed, it is important to adapt livestock farming activities to crop residues (products and by-products of food processing) and increase animal feed sources. Available as factory by-products (oil, brewery, sugar) through judicious use of crop residues mixed crop-livestock system [19]. The peanut industry provides many by-products that can be used as pet food, including fish.

The majority of peanut by-products come from peanut processing, including broken and spent peanuts, peanut powder, and peanut shells and shells. Peanut powder contains a list of essential nutrients for pets [20]. Ground nut cake has a relatively similar nutritional value to other foods, such as soybean meal, which is often used as a protein source in dairy animal diets and is expensive compared to ground nut cake. Although ground nut cake contains better nutrients, available data on the effects of peanut meal on the performance of dairy cows are limited and these aspects require detailed scientific research. Therefore, this study was designed to evaluate the effects of replacing ground nut cake concentrate on milk yield and evaluate its economic benefits.

1.2. Objectives

The main objectives of this research were:

1) To investigate the effect of ground nut cake on milk production
2) To analysis economic return of ground nut cake fed dairy cows

2. Materials and Methods

2.1. Description of Study Area

The study was conducted at Haramaya University Dairy Farm, located in Haramaya District, East Hararghe Zone, Oromia Regional State, Ethiopia, 500 km east of 'Addis Ababa, the country's capital [21]. Astronomically, the school is located at 9°26' North latitude and 42°3' East longitude, at an altitude of about 2000 meters above sea level, the average annual rainfall in the study area is d' about 870 mm, ranging from 560 to 1260 mm, average maximum and minimum temperatures are 23.4°C and 8.25°C respectively (unpublished summary report of the Weather Station Haramaya University). This area receives a bimodal rainfall distribution, peaking in mid-April and mid-August. There are four seasons: short rainy season (mid-March to mid-May), short dry season (late May to the end of June), a long rainy season (early July to mid-October) and a long dry season. (late October to late February). The main pastoral production is obtained after the short rainy season, continuing until the end of the long rainy season [22].

2.2. Management of Study Animal

Fifteen lactating purebred Holstein Friesian dairy cows were selected from the Haramaya University dairy farm and classified according to their lactation stage. Cows from 7 to 105 days of calving are classified as precocious, from 106 to 210 days as intermediate and from 211 to 315 days as late lactation [23]. All cows are from the same litter (odd one). Cows are fed a daily ration of 0.5 kg/liters, divided into 3 times per day at 6 a.m.; 2: 12 noon and 10 pm: hours with equal intervals of 8 hours and free access to water and space provided. Corn silage and hay were provided ad libitum as the main roughage sources. Cows are milked twice a day at 6 a.m. 00:00 a.m. and 4:00 a.m. 00:00 in the afternoon. Selected animals had an initial body weight of 428 ± 3.33 kg (mean ± SE).

Table 1. *List of percentage composition of experimental feed.*

Treatments	% of ground nut cake	% soybean meal	Order of treatments
T-1	100%	0%	Period I=T1, T2, T3
T-2	50%	50%	Period II=T2, T3, T1
T-3	0%	100%	Period III=T3, T1, T2

Where T-1 treatment one (source of protein is ground nut cake with other ingredients, zero soybean meal), T-2 = Treatment two (soybean meal and ground nut cake each with equal amount) and T-3 = treatment three (source of protein is only soybean with other ingredients, zero ground nut cake) respectively, I, II and III represent order one, order two and three respectively.

Concentrate feed, which contains mixtures of wheat bran, ground corn, salt dicalcium phosphate and minerals and vitamin premixes after formulation with the help of [24], were included to the experimental diet to form total mixed ration. The experimental rations were given for the animals before milking (during afternoon time), after milking (during morning time) and at the night with respective treatment. Corn silage and grass hay was offered *ad libitum* to the animals with the concern of 60:40 concentrate to forage ratio so that the rumen microorganisms function properly.

The experimental period was divided in to three and the experimental feeds were randomly assigned to each subject. Each period has twenty-five days and between each consecutive period, ten days of washout period were settled to avoid carry over effect (residual effect of the treatment). Milk Samples were taken three times after the 21st days of each period for analysis of milk composition. Measurements which were taken during the washout period were not used for analysis. To control the effect of the order of applying treatments, subjects were often randomly assigned to cows of early lactation, mid-lactation and late lactation. Cows in early lactation received treatment one, mid lactating cows on treatment two and late on treatment three during period one. In period two, cows in early lactation fed treatment two, mid-lactation received treatment three and cows in late lactation received treatment one. During period three early lactating cows received treatment three, mid lactating cows on treatment one and late lactating cows were fed on treatment two. In general the experiment was conducted during dry season starting from December 2017-March 2018.

2.2.1. Milking Procedures

Firstly, the cows were provided a clean and low stress environment (free of strange and sound disturbances). This was aimed to avoid the fear that Excited or frightened cows may not have actual milk let down as the release of hormones during this condition to the blood stream can interfere the milk production. Secondly, the first milk and udder were checked for mastitis by means of visualization and palpation of the udder. Palpation of the udder was made on every cow at each milking to detect mastitis symptoms like hotness, pain and redness of udder. Then the first drawn milk was tested for abnormalities like "clotting, stringy or watery" milk by directly striping on strip cups; Stripping on hand is possible but avoided to prevent spreads of microbes from teat-to-treat and from cow-to-cow. Thirdly, the udder and the teats were washed before every time of milking by using hot water and individual towel. Fourthly, the teats were completely dried with an individual towel. A separate cloth towel was used on each cow and towels were laundered and dried after each milking. Lastly, the vacuum was shut off before removing unit. Incorrect removal of the milking unit can have a detrimental impact on udder health [25].

2.2.2. Milking Utensils

Stainless steel milking equipment like metal buckets and milking machine which are easier to clean; easily loose heat so help to cool the milk and which minimize the growth of microorganisms were used. In addition to these 250ml glass bottles (to take samples to laboratory), plastic containers (to hold water and towels to dry and to wash the teats and the udder) were used during the experiment. Though the milk sold soon after milking and consumed freshly, metallic milk tanks were used to store milk until transported to the milk selling room.

2.3. Economic Analysis

The profitability of the milk production during the period of experiment was computed. Benefit cost ratio, which is the best measure of profitability, was carried out. The collected data regarding cost components and milk production were expressed in percentage and ratios. The economic feasibility of this study was analysed using benefit cost ratio. The total amount of feeds ingredients in experimental periods were calculated by multiplying percentage of each ingredient with parts in quintal and from this, daily intake of each ingredient obtained. Then from this, the amount of each ingredient consumed in a day multiplied by its unit price. Total price in each period was computed by multiplying total number of cows and total number of days and the total cost was computed adding the cost of all ingredients. The total milk production income was calculated by adding the total milk sale value and money obtained from manure. Many researchers consider the sale of calves, died cows and calves as sources of income in dairy farming but in current experiment they were not included because such conditions did not happen during the experiment. Therefore the income was limited only to milk yield and that of manure sale.

2.4. Experimental Design

The experimental animals were assigned to a crossover design experiment. Experimental units were blocked based on stage of lactation and randomly assigned to one of the three treatments. Concentrate feeds were formulated to meet nutrient requirements of dairy cows after the analysis of its chemical composition [26].

Model:

$$Yijkl = \mu + Ti + \beta k + SUB(\beta)jk + tl + Eijk$$

i = 1… a; j = 1… nk, k = 1… b; l = 1…a

Where:

Yijkl = observation on subject *j* with treatment *i*, order of treatment *k* & period *l*

μ = the overall mean

Ti= the fixed effect of treatment *i*

Bk= the effect of order *k* of applying treatments

SUB (β) jk= the random effect of subject *j* within order *k*

Tl= the effect of period *l*

Eijkl= random error with mean 0 and variance σ^2

a = number of treatments and periods; *b* = number of orders;

nk= number of subjects within order *k*;

$n = \Sigma nk$= total number of subjects

2.5. Statistical Analysis of Data

For statistical analysis the data which concerned with chemical composition of experimental feed ingredients were analysed by SAS 9.0 under completely randomized design. Data related to milk yield, quality and quantity were analysed using Analysis of Variance (ANOVA) through the General Linear Models (GLM) procedure of the statistical analysis system software (SAS 9.0). Least significant difference used to separate means at p<0.05.

3. Results and Discussions

3.1. Milk Yield

The results of dietary treatment effect and period effect on milk yield were presented in Table 2. The treatment and periods during which the treatment applied were significantly (P<0.05) affected milk yield. The highest milk yield (467.75liter/cow) was recorded when the animal fed on treatment one (T1). This might be due to the crude protein content of the treatment (ground nut cake, higher protein than T2 and T3) which enhances the milk production through initiation of the cows to exploit their potential. The result of the current study agrees with [27] who reported that milk yield and protein yield were significantly improved in diets rich in proteins. Providing adequate protein increases milk production under tropical condition [28] because it increases the availability of ammonia, peptides and amino acids for microbial growth in the rumen. The current result disagrees difference of diet protein did not affect the milk yield [29]. The result of [30] also showed that dietary crude protein levels had no effect on milk yield in Holstein cows. Daily Milk yield was significantly different among treatments (P<0.05) and was higher in T1 as compared toT2 and T3. Cows fed with sole ground nut cake (T1) produced more milk than those in T2 and T3 treatment diets. Generally, cows fed the sole GNC (T1) produced 540 and 750 ml more milk per day than T2 and T3respectively. The difference in milk yield among treatment groups is attributed to the differences in crude protein and energy contents in the diets Steinshamn [29]. Supplemented cows produced more milk than those grazed on natural pasture alone [31]. Period has statistically significantly (P<0.05) influenced the milk yield; accordingly the highest milk yield (462.5liters) was recorded during period two of the experiment. This may be due to the application of treatment one (which increased milk yield in early cows during period one), for mid cows and treatment two which contains almost equal crude protein of different source (half from soybean and half from ground nut cake). From this experiment it can be summarized as increasing the crude protein can increase the milk yield.

Table 2. *Average daily milk yield in each period and treatment.*

Treatments	MY/Cow/Period	ADMY
T1	467.75^{a}	18.71^{a}
T2	454.25^{b}	18.17^{b}
T3	449.00^{c}	17.96^{c}
p-I	458.75^{ab}	18.35^{b}
p-II	462.50^{a}	18.50^{a}
p-III	452.25^{b}	18.09^{ab}

Means with different superscript letters in the same column are statistically different at P<0.05, ns=not significant. Where: ADMY=average daily milk yield, LA=lactic acid, MY=milk yield, p=period, pro=protein, SNF=solid not fat, Trt=treatment and TS=total solid.

3.2. Milk Production Cost and Returns

The result of costs and returns of milk production of all experimental periods were carried out based on different cost concepts and it has been shown separately in respective tables.

3.2.1. Milk Production Costs

The cost of milk production during each experimental period was calculated based on different cost components of variable costs. The result of all these costs were calculated for treatment and each period and presented in Table 3. The average cost of production per cow per day was not significantly different nonetheless of periods differences. The highest cost of milk production per cow per day (79.9ETB) was found for T1 and the lowest (74.3 ETB) was obtained forT2. This may be related to the similarity of the amount of feed consumed and relatively equal price of ingredients used in the experiment. Feed cost is the biggest cost for milk production; therefore, it is vital to minimize its extent [32]. Another aspect of minimizing feed costs is to strive for a feed ration composition with high efficiency [33] the feed ration is designed in a fashion that utilizes the complementary qualities of different feeds in order to reduce required amount. In other words reduce waste in the feeding process due to over-feeding of expensive nutrients.

The following formulas were used to calculate the total cost.

$$\text{Variable cost} = \text{cost of rouphage} + \text{cost of concentrates} + \text{labor}$$

$$\text{TVC} = \text{cost of}\{(\text{silage} + \text{hay}) + (SBM + PM + maize + WB + minerals) + labor\}$$

Table 3. *Costs of milk production.*

Fixed Factors		cost/cow/day	cost/liter	Total cost /cow/period
Period	I	74.0^{b}	4.03^{b}	1850.0^{b}
	II	78.7^{a}	4.25^{a}	1967.5^{a}
	III	78.7^{a}	4.29^{a}	1967.5^{a}
Treatments	1	79.9^{a}	4.27^{b}	1997.5^{a}
	2	74.3^{c}	4.09^{c}	1857.5^{c}
	3	78.8^{b}	4.39^{a}	1970.0^{b}

Values with different superscript letters in the same column are statistically different ($P< 0.05$) according to LSD SAS 9.0. All costs were expressed in Ethiopian birr (ETB).

3.2.2. Milk Production Incomes

The result of milk production income was given in Table 4. Accordingly, the highest gross milk production income (133560ETB) obtained from cows fed on treatment one (T1) and the income (129480 ETB) obtained from treatment two. Here the difference is 4080ETB; this is due to the difference in milk yield as the milk production was higher when cows fed T1. The current finding agrees with the idea that the total income from milk was highly dependent and influenced by variable costs [35, 36]. The computed Incomes from dairy cows during the experiment goes with the idea of [37] who reported Gross production value of milk production is comprised of value of milk and dairy products produced on the farm and value of manure sale.

$$\text{GMPI} = \text{Total liter of milk per day} * no.of\ cows * total\ number\ of\ days * milk\ price$$

$$\text{Total Milk Production Income (C)} = \text{Gross milk production Incom} + \text{value of mannure}$$

$$\text{Net milk production Income (NMPI)} = \text{Total milk production income} - \text{Totalc cost}$$

Source: *[34]*.

The BCR = was calculated by using the following formula:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross Revenue}}{\text{Gross Cost}} = \frac{\text{Total Revenue}}{\text{Total Cost}}$$

$$\text{BCR} = \frac{\text{TI}}{\text{TC}}$$

Where: TI= Total Income, TC= Total Cost.

3.2.3. Economic Return of Milk Production

The result of economic return from milk production is given in Table 4. Net Return which is a measure of true economic income in dairy farming was calculated as the difference of income coming from milk and milk production cost including all the cost items [36]. The result of net return of all periods under each experimental diet was positive and this indicates the profitability of the farm when cows fed on the formulated ration. The cost of production except feed cost, were constant and feed cost was the only factor that differed as cost of production. The result of the revealed that higher profit can be gained if ground nut cake at dry matter basis added to the ration. The present result also showed that ration containing different level of ground nut cake in the concentrate mix was economically feasible without affecting the dry matter intake and body weight gain. This is due to the potential of ground nut cake to increase the milk yield because of its good protein content and it's relatively low price (7.5ETB per kg unit cost) of ground nut cake when compared to the price of soybean meal (12.5 ETB/kg). The currently obtained benefit cost ratios were greater than 2.11 of [37, 38]. It can be summarized as ground nut cake increases the return from milk production which in turn increased the profitability of dairy.

Table 4. *Return from milk production during the experimental period.*

Periods	MY Kg	Return from milk	Return from Dung	Gross Return	Total Cost	Net Return	BCR	NDR
Period-I	6693	133860	600	134460	29250	105210	4.60:1	281
Period-II	6573	131460	580	132040	31434	100606	4.20:1	268
Period-III	6373	127460	500	127960	30707	97253	4.17:1	259
Treatment-I								
Trt=I	6648	132960	600	133560	30270	103290	4.41:1	275
Trt-II	6446	128920	560	129480	29295	100185	4.42:1	267
Trt-III	6543	130860	520	131380	30826	100554	4.26:1	268

BCR: Benefit cost ratio, MY: Milk Yield, NDR: Net Daily Return

The price of milk in the current result was considered as 20 ETB according to the information obtained from the milk market price at gandaboi, around Haramaya University.

4. Conclusions and Recommendation

4.1. Conclusion

Nowadays milk yield per cow and the cost of feed to produce milk have by far the greatest influence on profitability in dairy production. Inadequate nutrition both in quantity and quality among milking animals especially during the dry season, is considered to be the major limitations to dairy productivity in Ethiopia. In the present scenario, the cost of concentrate feeds even the cost of grass hay is skyrocketing. One possible means of mitigating such constraints is to introduce by-products of least cost but equally competent with expensive feeds for quantity and quality milk production.

Generally, the replacement of ground nut cake for soybean meal increased milk yield and economic return improved.

4.2. Recommendations

Ground nut cake is very important source of nutrients especially protein. It has the ability to improve the performance of lactating dairy cows. Supplementing dairy cows ground nut cake has increased the milk yield and the return of lactating dairy cows. Therefore I recommend the dairy producer to use the ground nut cake to supply their dairy cows instead of expensive protein source feeds. Ground nut cake has to be specified as a potential source of protein in the diets of lactating dairy animals. Future research is required as concerned these points.

Conflicts of Interest

The Author declares that there is no conflict of interest with regards to this manuscript.

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